Targeting conservation site selection for water quality improvements

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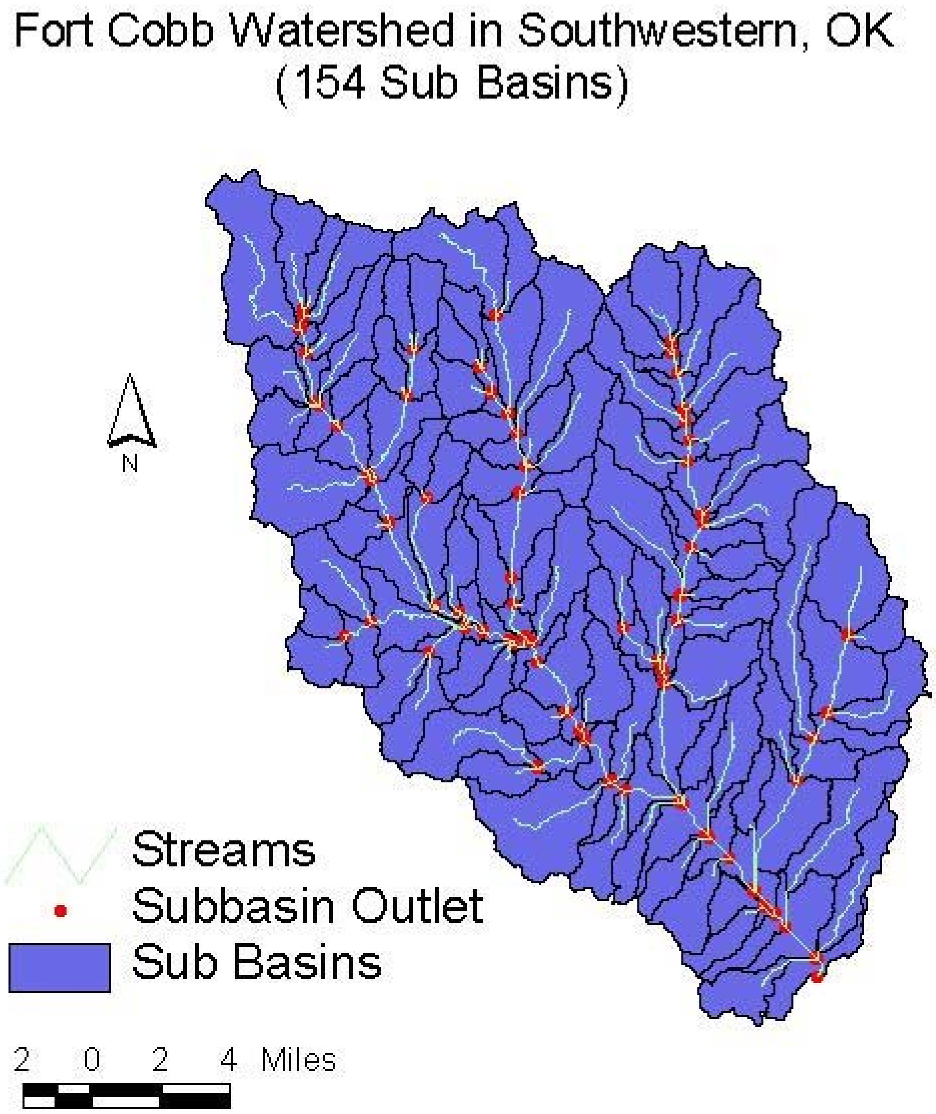
Modeling biophysical and economic consequences for ecosystem and land use management.

- GIS is provides spatially referenced geographic information and economic information
- The past 3 decades has also seen a proliferation of hydrological models to simulate best management and real world consequences of environmental problems such as non-point pollution.
- Economists use this hydrological data on nutrients, erosion, and pesticide to optimize, target, or simulate outcomes from conservation programs.

- How have economists combined these models to look at non-point pollution and CRP and why might these fall short?

- The Purpose of the Hydrological Model: to predict the effect of management decisions on water, sediment, nutrient and pesticide yields (see Gowda, JAWRA, 1999)
- 3 main issues of spatial scale, temporal scale, and complexity.
  - 1. Physical scale
    - Research on Non-point pollution usually occurs on plots or fields over a few years—how to scale up?.
    - Models work very differently, i.e.., ADAPT (Chung et al, 1992) and SWAT 2000, Arnold, Jeff et al)
    - Spatial pattern of sites/activities matters--Most predict pollutant loadings at watershed outlets (see next map), but this may not work with drainage or irrigation, and does not always consider flow through regimes

Example of Sub-Basin division using SWAT



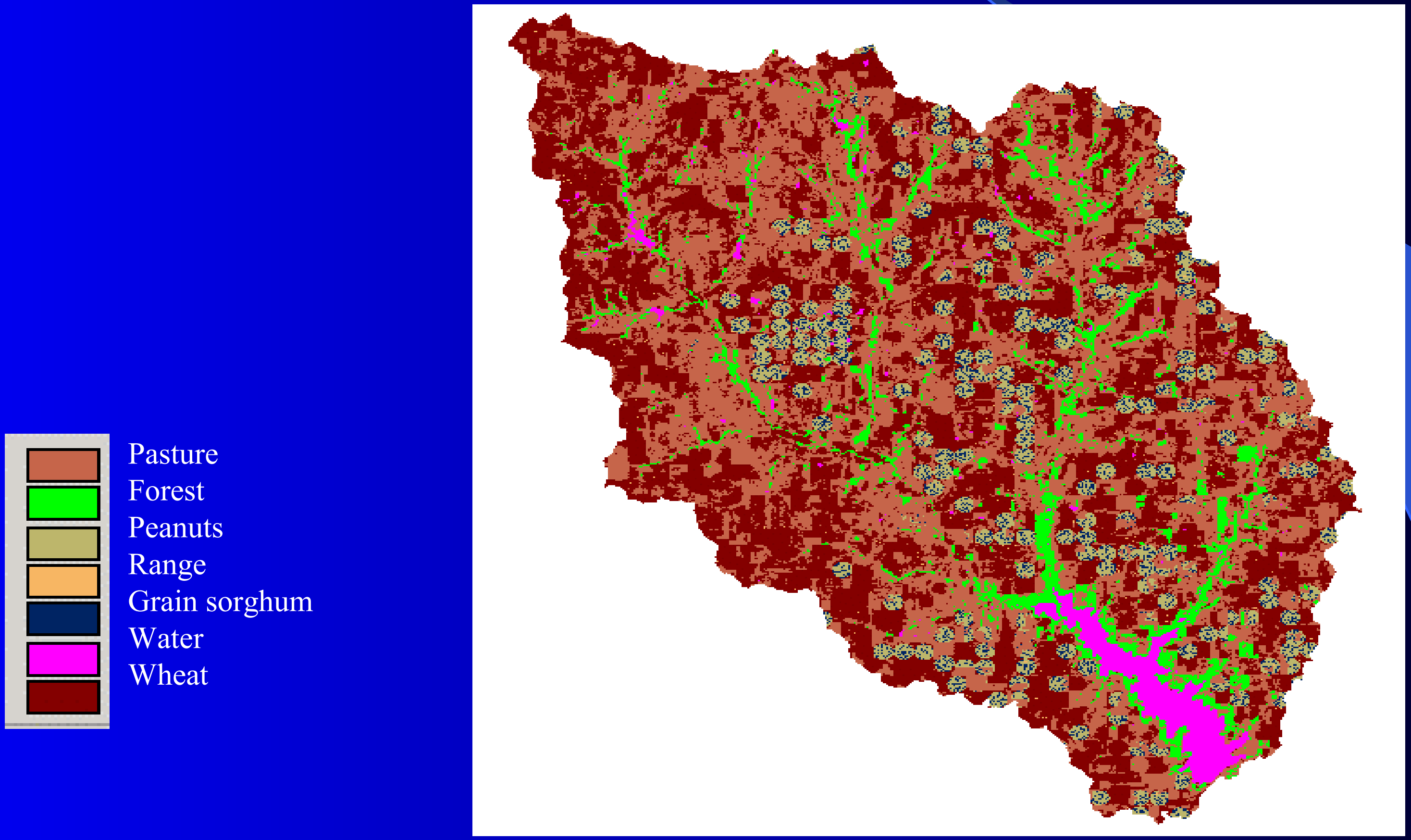
2. <u>Temporal Scale</u>
   - Temporally, loading and leaching may vary considerably
   - For long term analysis include climate variability, we may need decades of field data
   - Policy is often concerned with Total Maximum Daily Loads in watersheds (TMDLs), meaning we are concerned with peaks and average flows
3. <u>Complexity:</u>
   - Dynamic issue (yields held average over time), non-linearity
   - Scientific repeatability and universality?

Tying in Economic Models

- Simulation (Newbold, 2002)
- Math programming (using a hydrological model as a loosely coupled input)
    1) <u>Reserve Site Selection or Land Retirement targeting</u>—Target CRP for water quality, species preservation, or wetland restoration (Khanna et al 2003, Boyer, 2003).
    2) <u>Linear Programming</u>--Obtain abatement of sediment, nutrient, or pesticide loading at least cost over CRP and conservation practices (Westra et al, 2002, Boyer, Geza, and Adams, working paper.)

Land Use in Fort Cobb Basin

An LP optimization example



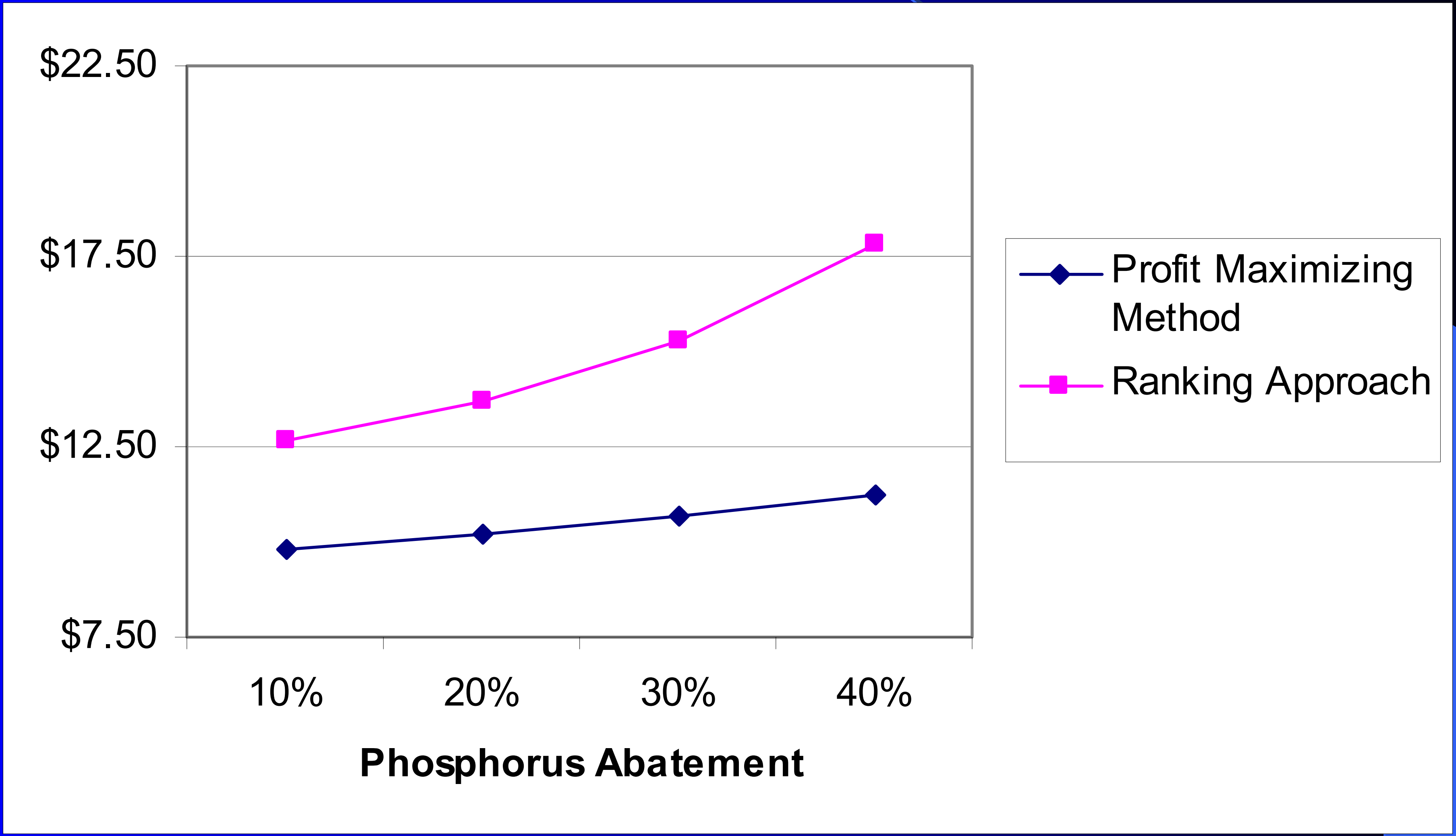
Least Cost Targeting Example

- **Policy 1** : First retire worst erosion/acre sites to obtain 10% and 20% phosphorus reduction (simple ranking, no budget constraint)

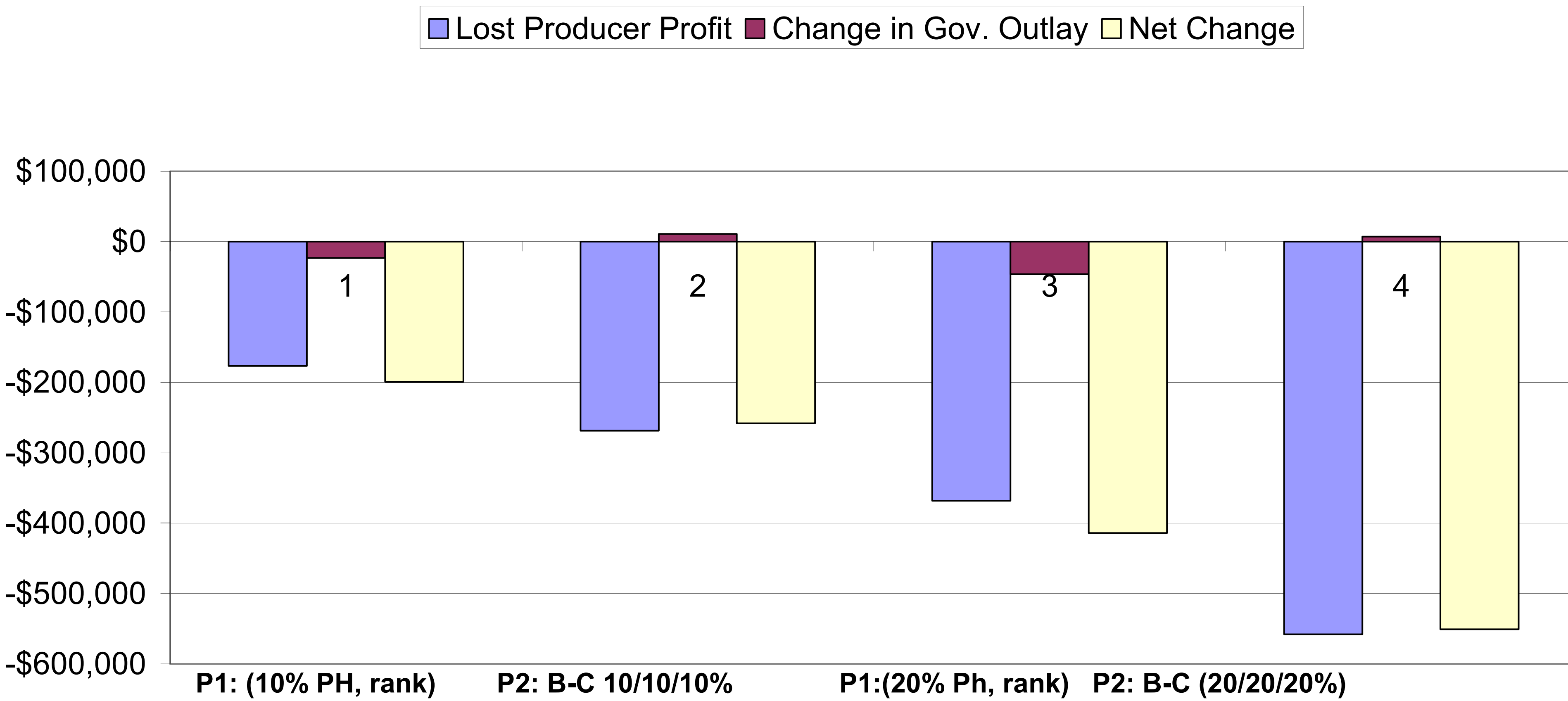
- **Policy 2:** Obtain objective at least cost: Maximize producers returns (R-C) subject to constraints on Sediment, Nitrogen and Phosphorus at 10% and 20% each of current levels.

Social Cost/ LB Phosphorus

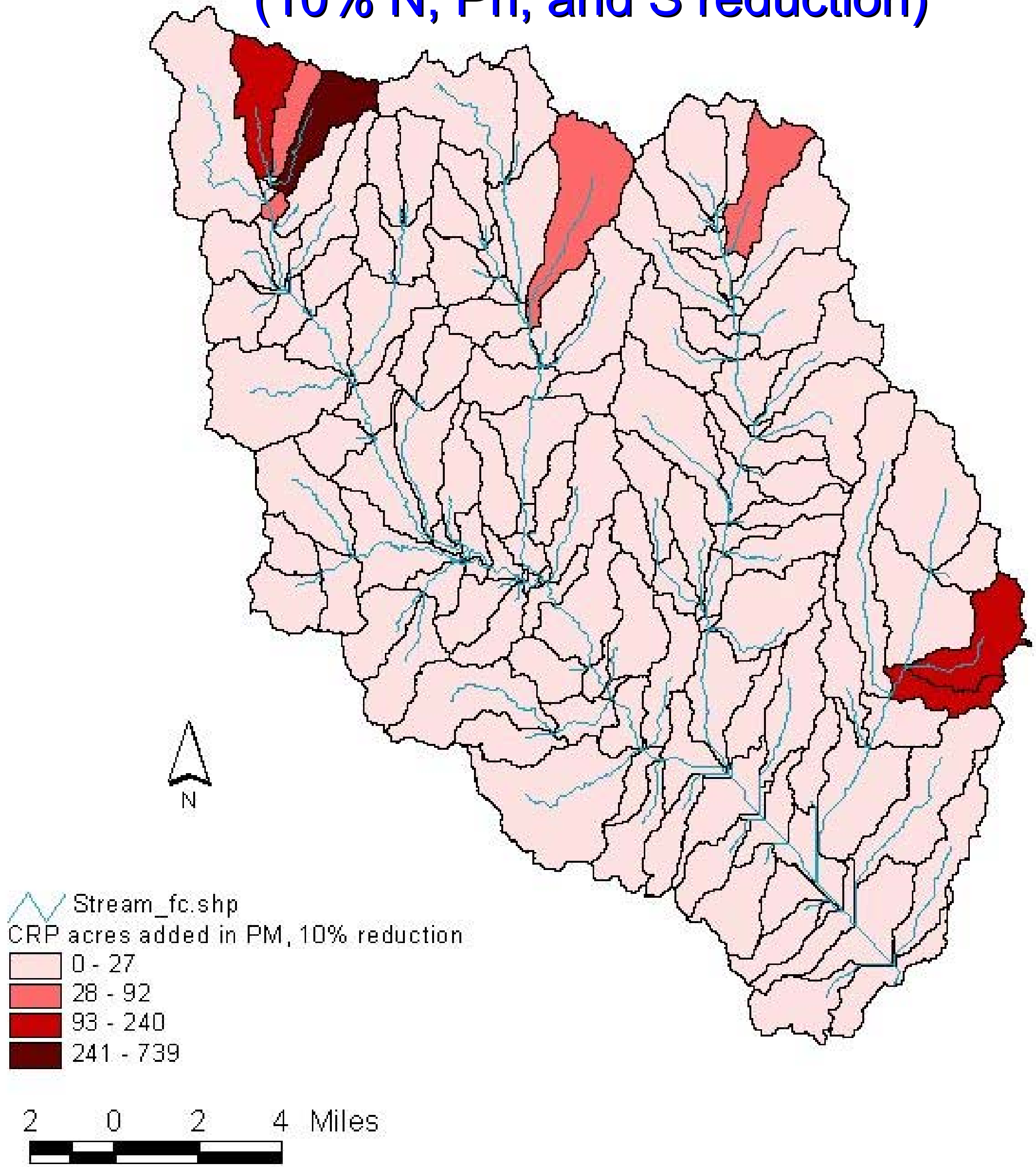
(Policies 1 & 2)



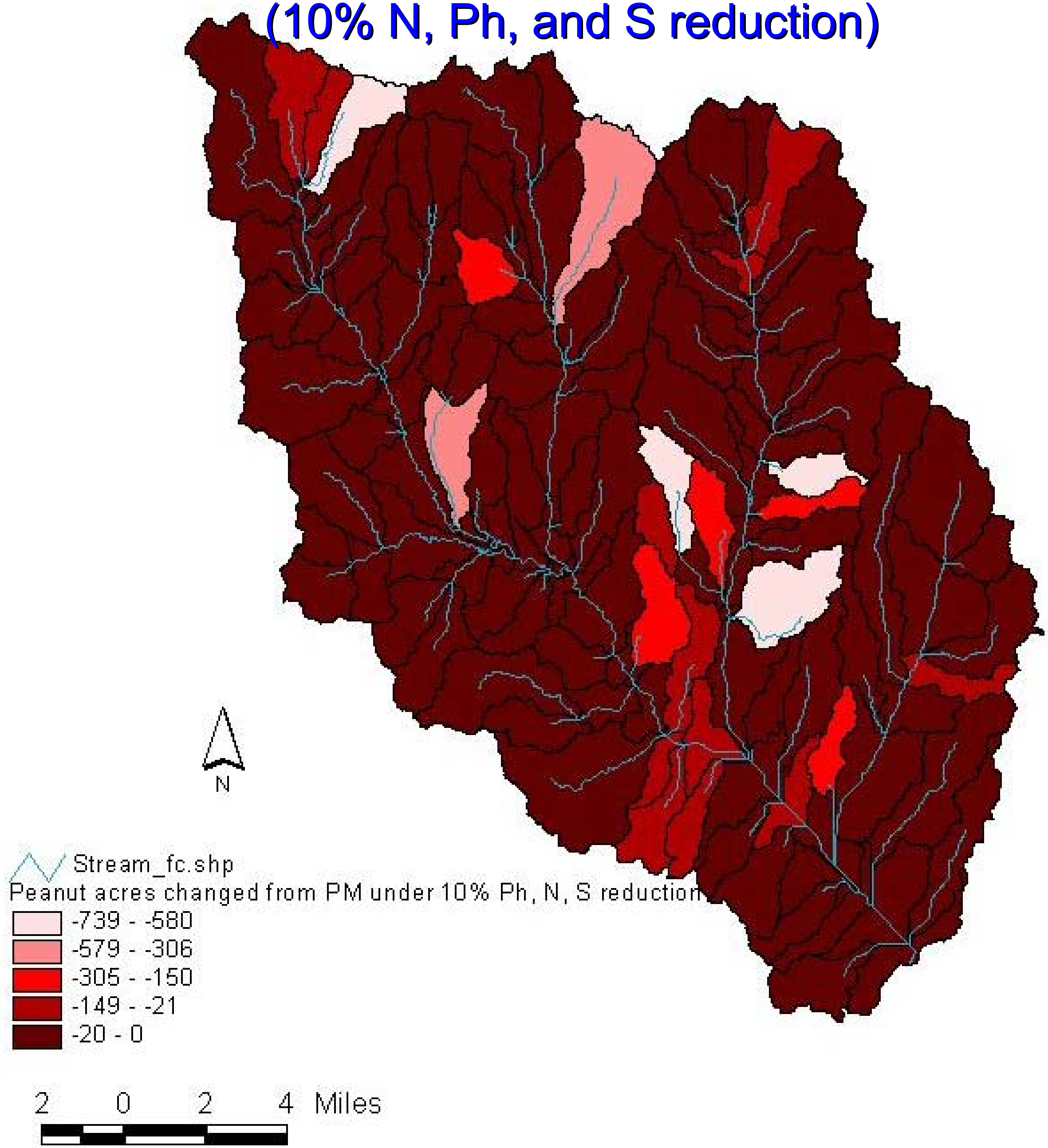
Welfare Effects: Un-constrained ranking vs. budget constrained optimization to reduce phosphorus by 10% and 20%



Additional CRP acres enrolled by Sub-Basin (10% N, Ph, and S reduction)



Lost Peanut acres by Sub-Basin
(10% N, Ph, and S reduction)



Issues for Future Research

- Region specific (Benefits/concerns vary)
- Spatial pattern matters
- Corollary, spatial pattern matters particularly when also considering multi-objective outcomes
- Additional information needed on "best" restoration outcomes for water quality
- Targeting vs. eligibility
- What are "2nd Best" ways to target to achieve benefits at least cost? (i.e., lowest transaction costs)